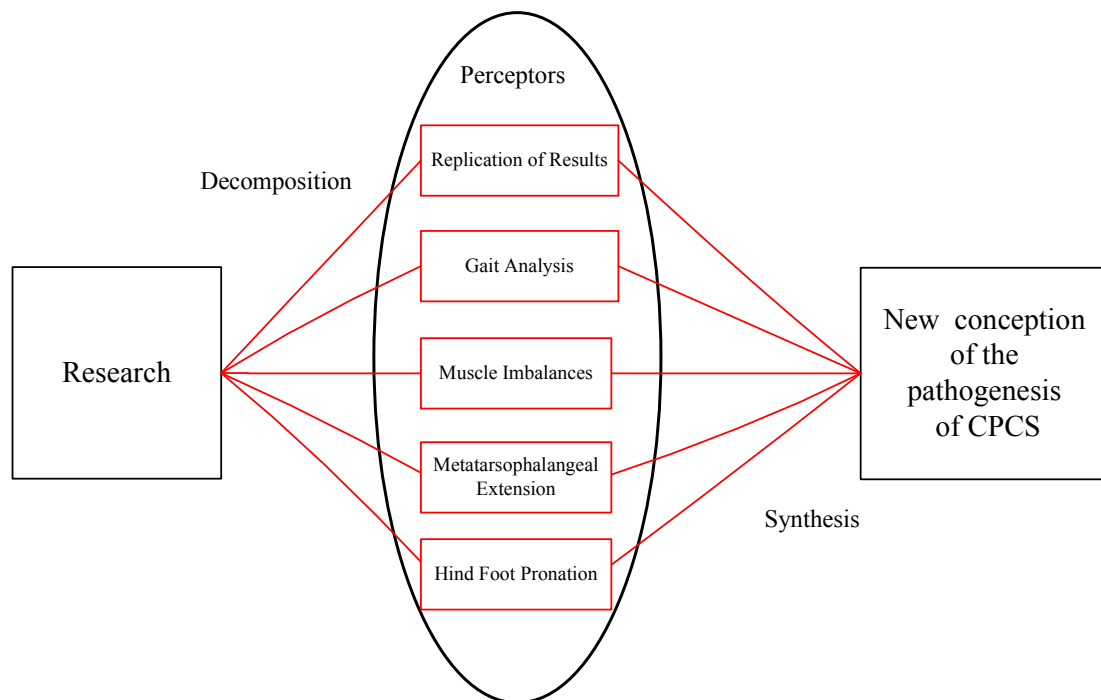


## CHAPTER 5

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1. INTRODUCTION

The objective of the final chapter is to provide an overview of the research project. It reviews the extent to which the key research objectives have been achieved. It provides the final discussions on the integration of the results that were achieved during the research. The Brunswikian model (Schulz & Tietje, 2002) is used as a conceptual framework for the final integration of results. Through this integration of the various results of the individual research components reflected in Figure 5.1, a new and enhanced understanding of the pathogenesis of CPCS emerge.



**Figure 5.1: Towards a new conception of the pathogenesis of CPCS**

The various research phases of the research project were covered in detail in the individual chapters dealing with each of the research aspects. In this chapter the final perspectives on the research project will be covered. The perspective emanating from the integration of the individual results of the different research phases provides a new understanding of the pathogenesis of CPCS, as well as of the implications which this new perspective has on treatment interventions developed during the course of the

research. Some of the major highlights, short comings and future research questions that need to be addressed will be highlighted.

## **5.2. KNOWLEDGE INTEGRATION**

In this section the knowledge gained during the various sub research projects will be integrated based on the conceptual framework presented by the Brunswikian lens model (Schulz & Tietje, 2002). The aim is to identify those aspects of the research findings of the individual components which enable a clearer and an enhanced picture of the research findings. Central to the integration of the knowledge gained is the new or revised theoretical model that has been developed for the pathogenesis of CPCS.

In Chapter 2 the model by Scholz & Tietje (2002) for the generation of knowledge through case study research has been introduced. In terms of this model three levels of knowledge exist. The first level represents knowledge gained from individual case studies. The knowledge gained on this level is generalised through the creation of a conceptual model on the second level. This model according to them is based on inference drawn from the observations from the individual case studies. This model can be validated by means of its ability to explain outputs from the case study research, such as data, observations, measurements, surveys, documents and expertise, as well as data from the existing body of scientific knowledge in the form of disciplinary propositions.

Contrary to this model, the conceptual model for the pathogenesis of CPCS was based on deductive thinking and the deficiencies in the current theoretical base. In the opinion of the researcher it would not have been possible to formulate the revised theoretical model for the pathogenesis of CPCS through inference made from observations.

### **5.2.1. Replication of results**

The central proposition with each of the case studies was that the symptoms of CPCS will manifest as a result of tightness in the *clinically significant muscles*. This tightness is the result of a decrease in the functional length of the myofascial chain

which reflects in a stiffness/tightness of the *clinically significant muscles*. When the tightness in these muscles is released by means of soft tissue mobilization interventions, the condition will clear and that the subject would be symptom free. In other words, the subject will be pain free and would be able to resume his running career in a normal manner. The results with all eight subjects were successful and through this replication of results the validity of the model was verified.

### **5.2.2. Muscle tightness**

Muscle tightness in the *clinically significant muscles* plays a key role in the revised model for the pathogenesis of CPCS. The identification and classification of these muscles as being significant in the condition of CPCS are one of the key contributions to new knowledge generated by this research. These muscles were identified based on their relationship with the continuous myofascial web which interlinks them with the muscles of the posterior compartment. These muscles were identified based on deductive reasoning from existing anatomical knowledge of fascia, supplemented by clinical verification during the analysis of the subjects during individual case studies.

One of the implications of the *clinically significant muscles* is that tightness in any of these, due to the continuous nature of the myofascial web, could be responsible for the symptoms of CPCS. This implies that the tightness in these muscles could vary from subject to subject, which was indeed the case as observed with the individual case studies.

### **5.2.3. Muscle imbalances**

Tightness of the *clinically significant muscles* lead to a constriction in the length of the myofascial chain which in variably affect the normal functioning of the muscles involved. These results although predictable, do not make any significant contribution to the research per se, other than being consistent with expectations in general. Muscle imbalances per se do not imply that the subject suffers from the symptoms of CPCS, although it could be stated that subjects with symptoms of CPCS would have significant muscle imbalances.



#### **5.2.4. Gait analysis**

Gait analysis as a tool provided the ability to evaluate the effects of CPCS in the subjects in a dynamic manner. Although it is difficult to predict all the effects of CPCS on the dynamic movement patterns, it is relatively easy to motivate the observed abnormal movement patterns based on the theoretical model that has been developed.

The gait analysis was also instrumental to the experimentation with the metatarsophalangeal extension. In retrospect the effect of CPCS on the flexibility at the metatarsophalangeal joint seems obvious. Although the measurement of biomechanical angles was one of the objectives set at the outset, this particular measurement was a direct outflow from the gait analysis conducted. The observations made during the gait analysis were all supportive to the new theoretical constructs that were developed.

#### **5.2.5. Biomechanical measures**

The implication of the continuous and relatively inelastic myofascial web that links the muscles is that stresses in the fascia controls or limits the extent of movement like a puppet on a string. Distortions in the fascia web will manifest in other areas such as the posterior compartment, which could indeed trigger the initiation of CPCS as a result of accentuated forces induced in the posterior compartment during running. The revised model for the pathogenesis of CPCS proposes that this is the most likely cause of the initiation of the condition which is a more credible explanation than the previous model which ascribed the cause to a general *muscle exertion*. Although no evidence could be found to the contrary, the initiation of the condition warrants additional research.

#### ***Metatarsophalangeal extension***

The constraint that compromised myofascia places on movement patterns is adequately demonstrated by this experiment. The restricted available length of the myofascia restricts the movements of the soft tissue. Therefore the subject goes higher



onto his toes in order to compensate for the reduction in the functional length of the myofascia web which restricts the flexibility in the ankle. The release of the myofascia through soft tissue mobilization techniques increases the available length of the myofascia which in turn leads to the normalisation of movement patterns.

### *Hind foot pronation*

Although all the subjects in the hind foot pronation experiment did not suffer from symptoms of CPCS, they all had abnormal hind foot pronation. The experiment however adequately illustrates the causal relationships between the intertwined myofascial web and abnormal movement patterns. The compromised fascia is reflected by the tightness in the clinically significant muscles, and once these tightnesses are released, movement patterns are normalised.

The experiment however also illustrated how the muscle tightness could be identified by relatively inexperienced health practitioners. It also provides evidence that the interventions could be applied by therapists, other than the researcher.

### **5.3. THE RESEARCH PROBLEM**

The research problem that had been investigated was the fact that no known conservative interventions existed which provided reputable successes in the treatment of the symptoms of CPCS (Fraipont & Adams, 2003). The only interventions with some positive responses in the literature were based on the surgical release of the fascia.

This fact, coupled to the lack of emphasis on the nature of myofascia, led to the search for a solution external to the calf area. The revised or modified model developed for the pathogenesis of CPCS were subjected to a rigorous process in search of the replication of results as well as the testing of rival theories that could have caused the initiation and perpetuation of the condition.



The emerging model for the development of CPCS formed the basis the development of the conservative treatment interventions which consisted of the release of the tightness in the so called or defined clinically significant muscles. The application of these techniques resulted in a spectacular success of all the subjects involved with the research project. All subjects were pain free at the end of the programme and could pursue their passion for running.

In conclusion one can state that there is overwhelming evidence that the research problem has been resolved.

#### **5.4. THE RESEARCH AND INVESTIGATIVE QUESTIONS**

In the literature research it was seen that although the condition of CPCS is well defined, it is not easy to identify or diagnose the condition. Some researchers such as Fraipont & Adamson (2003) even consider the measurement of the compartmental pressures as essential for establishing and accurate diagnoses. In the introductory chapter it has been stated that the healthcare practitioner thus often has to deal with a situation where the symptoms are clearly manifested, but the diagnosis of the underlying cause is not that obvious. One of the objectives of the research was to establish a practical methodology for the health professional to deal with this possible ambiguity. The focus of the research has thus been in dealing with these symptoms and the research question as was seen, was thus formulated as:

*Can a successful conservative treatment for runners with symptoms of CPCS be developed?*

From a theoretical perspective the research however focussed on the causal relationships of the condition. The lack of success with conservative interventions was considered to be due to a lack of understanding of the fundamental factors that contributed to the development and perpetuation of the condition. The relative successes that have been achieved with the surgical releases were a major element in the development of the revised theoretical model for the pathogenesis of CPCS, which enabled the development of the interventions. In the humble opinion of the researcher



it was thus possible to develop a successful conservative treatment intervention for the symptoms of Chronic Posterior Compartment Syndrome.

The lack of successful conservative interventions could thus be contributed to gaps that existed in theoretical base which reflects the understanding of the condition. Although the role of fascia in the context of the non-compliant border which leads to the pressure build up in the compartment is widely recognised, the continuous nature and non-elasticity of fascia had not been explored. Once this was identified it led to the exploration of the concept that the condition could be triggered externally to the calf compartments. This in turn led to the identification of the clinically significant muscles which are encapsulated by the continuous myofascial web is considered as the second most important contribution of this research.

It was argued that distortions of the myofascia in the clinically significant muscles would exert stresses and associated pressures along the myofascial web. This insight that the pressure in the calf compartments could be triggered externally, led to the development of the improved theoretical framework for the pathogenesis of the condition. The condition was thus triggered by an injury and not by some vague muscle exertion as proposed by the old theoretical model developed by Clanton & Solcher (1994).

The distortions in the myofascial web could be determined by means of the palpation of the tightness in the clinically significant muscles. Once these were identified it was possible to normalise the condition through the application of soft tissue mobilization techniques.

The application of the newly developed conservative treatment intervention was highly successful as demonstrated by a hundred percent replication of successful results with eight subjects. Through the replication logic of Yin (2003) the rival theories for the condition were systematically eliminated and the replication of the results provided adequate evidence to support the validity of the new model.

One of the investigative questions was whether other biomechanical deviations/abnormalities play a role in the perpetuation of the condition. The results of



the research suggest that such biomechanical deviations are indeed attributable to the condition, and not the other way around. It was also established that the successful treatment of the condition indeed normalised such biomechanical deviations.

The Brunswikian model in Figure 5.1 reflects the various components that were investigated in the research. These individual perspectives ultimately led to a richer understanding of the condition of CPCS. What is considered as significant is the fact that none of these perspectives or insights contradicts the new theoretical model that has been developed for the pathogenesis of CPCS. They all indeed support this new perspective.

## **5.5. KEY RESEARCH OBJECTIVES**

The key research objectives set for the research were all to a greater or lesser degree achieved. The first objective was to develop an enhanced theoretical framework as basis for the treatment of CPCS in runners. The new theoretical model that was developed formed the basis for the second objective which was to develop a successful conservative methodology for the treatment of CPCS in runners.

The new theoretical model is considered as a significant contribution to the current body of knowledge. More significantly however is the underlying implications which the inclusion of the myofascial web in the contextual framework of chronic injuries in general, holds for the development of conservative treatment interventions.

This approach makes a significant contribution to the existing body of knowledge with specific reference to a more holistic approach towards the clinical treatment of myofascial system related dysfunctions in the field of physiotherapy.

As a practising therapist, the most rewarding aspect of the research is the ability to solve the frustrating effects of CPCS in both the runner and the therapist who has to deal with the problem. As the experiment with the hind foot pronation has demonstrated, it enables even the relatively inexperienced practitioner to successfully deal with the problem.





## **5.6. SIGNIFICANCE OF THE RESEARCH**

The successful conservative treatment for the symptoms of CPCS is considered as a major breakthrough. The current physiotherapy approaches reported on in the literature provide no lasting success, whilst the documented surgical option has limited success rates, especially with regard to the posterior compartment.

A successful conservative approach, alleviating the symptoms of CPCS, could form the basis for the successful treatment of other chronic fascia-related injuries such as iliotibial band syndrome, plantar fasciitis and CCS of the other compartments of the lower leg, as well as others such as hamstring injuries where the individual muscle has a great many myofascial links to other areas.

The approach that had been developed for the treatment of the symptoms of CPCS has positive economical and psychological implications. Consequent upon successful treatment through manual, conservative means, costs are saved on surgery, hospitalisation, post-operative rehabilitation and many promising athletes will be able to continue their sport careers.

According to Harden (2007) the research in myofascial pain syndrome (MPS) is essentially at a standstill due to the lack of common, standard diagnostic criteria. In the opinion of the researcher this fact could to a large extent be contributed to the fact that the links which exist between muscles, ligaments and the fascia has been ignored in the theoretical base for the treatment of such related musculoskeletal problems. The application of these interdependencies could make a significant contribution towards the diagnostics of such problems and the treatment thereof.

## **5.7. THE RESEARCH PROCESS**

The use of the case study approach advocated by Yin (2003) was especially rewarding. His emphasis on an underlying theoretical model on which propositions can be based, forced the research to explore the validity of the current theoretical base



on which treatment interventions were based. The development and testing of rival theories that can be postulated to explain phenomena under investigation is a powerful tool that could be used with great success in a variety of situations. The critical evaluation process aimed at looking for evidence to disprove these rival theories is a valuable tool for health practitioners in terms of differentiated diagnostics.

The Brunswikian model in the manner in which it has been used in this research, is in essence nothing very different from *Methodological triangulation*. It however provides a useful graphical representation of how the different perspectives ultimately illuminate the picture under investigation. This approach of decomposing the research into different components also expands the context of analysis. It forces the researcher to look for causal relationships that cross the boundaries of the sub-problem under investigation that link the sub-problems with each other.

If it were not for ethical considerations, the validity of the research could have been enhanced. The fact that the three subjects from the exploratory research phase were included in the later explanatory phase could in certain circles be frowned upon. It would have been unethical not to subject them to the interventions that had been developed during the research project. To some extent there is merit in excluding the successful results achieved with the first three subjects from the results of the explanatory research phase. The complete lack of response with the interventions which focused on the posterior compartment in the mind of the researcher does not disqualify them as ultimate successes of the ultimate interventions that led to the successes.

The experimental research conducted during the research project should probably be viewed as pilot studies. No attempt has been made to subject the design or the analysis of the results to thorough statistical scrutiny. It did however achieve a number of objectives. In the first instance the results of both experiments support the theoretical model that was developed. The second experiment on the hind foot pronation also illustrated that the techniques could be applied by relatively inexperienced therapists. It also eliminated researcher bias through the application by others which increase the external validity of the research. It also provides opportunity for interesting future research which is not limited to runners with symptoms of



CPCS, but all subjects with biomechanical abnormalities where fascia related injuries could be the root cause of the problems.

## **5.8. THE RESEARCH DESIGN AND METHODOLOGY**

Research in the physical and natural world is not normally based on a qualitative approach. In some circles the term qualitative if used in the traditional sciences is frowned upon as research in these domains is normally based on the classical scientific method with well-established experimental approaches (Remenyi *et al.*, 2002). The main thrust of this research project was based on a qualitative, theory-building component, although supplemented by a quantitative component in the form of the experimental research components. If it was not for this very qualitative approach that was adopted, the researcher is of the opinion that it would not have been possible to develop the modified theoretical model for the pathogenesis of CPCS, nor the treatment interventions.

The use of multi-functional approaches in terms of both disciplines and methodologies offer a significant opportunity to create better understanding of unresolved problems. Little to no progress with the treatment of the symptoms of CPCS has been made during the recent past and the researcher is of the opinion that the adoption of the qualitative research approach is the major contributor to the successes that were achieved. In conclusion one must concur with Babbie (2005) that the use of both qualitative and quantitative methodologies forms the basis of a more complete understanding of the subject at hand.

## **5.9. CONTEXTUAL BOUNDARIES AND SHORTCOMINGS**

The research project was constrained to the subjective assessment of the condition in the subjects. This constrained was introduced by choice. By the very nature of the equipment and facilities available to the general physiotherapist, it is not possible to utilise sophisticated diagnostics techniques. In this context the therapist is frequently



forced to deal with the symptoms of the condition. In this regard the research is of immeasurable value as it provides an unsophisticated methodology that could be used to assess the condition of the subject. The muscle tightness that could easily be assessed by means of the soft tissue palpation techniques provides a useful way approach a subject with the symptoms of CPCS.

The fact that the diagnosis of the condition was based on this subjective assessment is in retrospect a possible shortcoming in the research. The actual measurement of the pressures in the involved compartment would have made a significant contribution to the external validity of the research. The results obtained are however so overwhelming that this shortcoming is not considered as too serious.

Greater sample sizes would have enabled the verification of the results on statistical basis. The strong link between the theoretical model and the propositions made based on the model however counters this argument. The degree of replication achieved, coupled to the triangulation of research methodologies provides sufficient evidence for the general validity of the new theoretical constructs that were developed.

From an ethical perspective it was imperative that the research was continuously focussed on the improvement of the subject's performance. The fact that intermittent strategies with controlled periods of no intervention, was not used is however not seen as a major limitation to the validity of the research.

Similarly the delimitations introduced by the researcher did not impose on either the quality or the validity of the research. The inclusion of the anatomically analysis of the myofascial structures would have made no significant contribution to the research and would have taken the focus from the real issue, which was the pathogenesis of the CPCS and the implications thereof on conservative treatment interventions. As stated earlier, the measurements of the actual pressures within the posterior compartment would have made a positive contribution, but is not seen as a serious distraction to the quality of the research project. The measurements of biomechanical effects were limited to aspects that made a direct contribution to the understanding of the theoretical model that was developed. Similarly this aspect is also not seen as a factor or an issue that constrained the quality of the research. It does however provide a vast



opportunity for future research into the effect of myofascial constraints on biomechanical measures.

## 5.10. RECOMMENDATIONS

The soft tissue myofascial web is a new frontier in sports medicine. This research project has demonstrated how the characteristics of the soft tissue web and its interaction with various muscles in the body could lead to the pathogenesis of chronic compartment syndromes in the body. Based on these findings it is recommended that much more attention is paid to fascia and the associated soft tissue in the assessment and treatment of sport injuries.

It is recommended that further research projects be launched in order to apply the same approach to runners with other chronic fascia related injuries such as iliotibial band syndrome, plantar fasciitis as well as chronic compartment syndrome of the other compartments of the lower leg.

The results that have been achieved with the normalization of movement patterns and associated biomechanics suggest that restrictions in the myofascial web should first be released before the introduction of “*permanent*” adaptations such as insoles and inserts. The interaction between the myofascial system and the joints is dynamic and needs to be balanced and stabilized before the introduction of strengthening and final rehabilitation.

The research project also illustrated the power of qualitative research approaches in areas where gaps in the current theoretical bases exists. The utilisation of such qualitative approaches coupled with the concept of the triangulation of results as encountered in mixed-methodological research paradigms are strongly recommended.